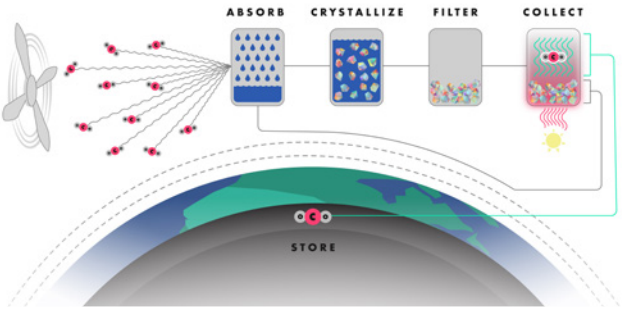
OAK RIDGE NATIONAL LABORATORY

Fossil Energy and Carbon Management

Oak Ridge National Laboratory (ORNL) is focused on the research, development, demonstration, and deployment of advanced technologies to minimize the effects of fossil fuel use. These technologies include carbon capture, storage, utilization, and conversion and low-carbon power generation.. ORNL scientists and engineers draw on the Laboratory's world-class capabilities to produce breakthroughs—from new materials and chemical processes to applied technologies—to manage carbon dioxide in the pursuit of reducing carbon emissions to net zero by 2050.



ORNL scientists developed a new class of receptors that absorb CO_2 from the air into aqueous solutions and convert it to crystalline carbonate salts. The project won an R&D 100 award.

Research and Development

Direct-air carbon capture and advanced equipment designs—Developing and demonstrating methods to utilize building air systems for direct-air carbon dioxide capture

New materials for direct-air carbon capture—Demonstrating energy-efficient methods for carbon dioxide capture using recycled sorbent materials

Conversion technologies—Developing novel hybrid material designs for one-step energy-efficient capture and conversion of carbon dioxide into valuable chemical products that avoid current toxic approaches

AI, modeling, and data analytics—Developing artificial intelligence (AI) models to predict the feasibility and long-term security of underground carbon dioxide storage sites and analyzing the feasibility of converting existing oil, gas, and other product pipelines to carry hydrogen

Transformational Decarbonization Initiative—ORNL's initiative focusing extensive fundamental science and applied technology capabilities on innovations for carbon capture and clean efficient utilization and conversion of captured CO_2

Advanced manufacturing—Demonstrating new techniques for low-cost flexible manufacturing of components to support renewable and low-carbon power generation and for direct-air capture of carbon dioxide from industrial processes

INNOVATING materials and sensors for low-carbon power

ENGINEERING sorbents, solvents, and membranes for CO_2 solutions

DEVISING AI-based algorithms to evaluate carbon storage

MODELING concepts using supercomputing to speed research

CONVERTING CO_2 into chemical and sustainable fuels such as methanol and formic acid

"We designed and demonstrated an additively manufactured device that significantly enhances capture of emissions from fossil fuel plants and other industrial processes."

—Distinguished R&D Staff **Costas Tsouris**

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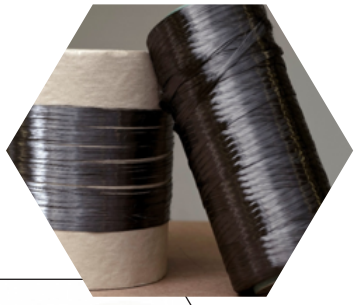
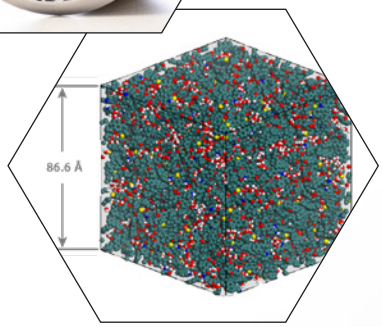
Recent Impacts





Additively manufactured carbon-capture technology—Creating a novel device that significantly enhances the capture of carbon dioxide emitted from fossil fuel plants and industrial processes. By using additive manufacturing, researchers custom-designed a multifunctional device that resolves the challenge of thermal management when solvents are used to absorb carbon dioxide from smokestack flue gas streams.

Retrofitting equipment for carbon capture—Integrating a multifunctional cooling tower to complement existing rooftop HVAC equipment that deploys system controls to optimize the performance of both cooling and carbon-capture functions. The cooling tower integration allows for the direct-air capture of carbon from the atmosphere.

Reducing cement carbon emissions—Working with industry to develop a breakthrough carbon-capture process that will close the loop on carbon emissions released from cement plants. By developing, optimizing, and scaling up carbon-capture process components that can be integrated into cement plant production, the carbon footprint is reduced via technological upgrades.

Evaluating carbon dioxide underground storage facilities—Using tracers to study the transport of carbon dioxide injected into the subsurface at the Cranfield site in Natchez, Mississippi, is a unique test of carbon dioxide storage security.

Developing coal-derived carbon fibers and graphite for clean energy technologies—Developing unique methods to convert coal-derived feedstocks into carbon fibers for lightweighting advanced vehicles and aircraft and for buildings thermal insulation; manufacturing low-cost, high-capacity, durable anodes for advanced batteries.

The US Department of Energy's (DOE's) Most Comprehensive R&D Facilities for Carbon Capture and Utilization

ORNL's Grid Research Integration and Development Center (GRID-C) focuses on solutions for a clean, modern national power system that prioritizes renewable and low-carbon energy. GRID-C features a high-fidelity simulation of every segment of the grid, including power generation, transmission, and end use, so advances can be thoroughly developed, tested, and validated for deployment.

DOE Building Technologies Research and Integration Center is the only User Facility devoted to building technologies research and development.

DOE Manufacturing Demonstration Facility houses integrated capabilities to drive the development of new materials, software, and systems for advanced manufacturing technologies that support the secure production of clean energy products.

DOE Carbon Fiber Technology Facility is DOE's only User Facility focused on carbon fiber innovation, including the development and demonstration of hydrocarbon-based precursors.

World-class materials development and characterization at ORNL spans unique neutron science and nanophase science facilities, the fastest US supercomputer, and other basic science capabilities unmatched in scale and scope at a national laboratory. These facilities advance our understanding, design, and use of new materials and chemical processes to realize success in energy and the environment and provide economic benefit and security to the nation.

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